



**SYSTEMS ENGINEERING DEFINITION AND
ANALYSIS**

Reliability & Maintainability

Essential Elements of Systems Engineering

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Systems Engineering

“ An interdisciplinary, collaborative approach to derive, evolve, and verify a life-cycle balanced systems solution which satisfies customer expectations....”

IEEE P1220, Standard For Application and Management of the Systems Engineering Process

Systems Engineering Process Often Diluted Due to Program Fiscal Constraints

- **In the quest for lower acquisition cost, minimal attention is given to R&M issues which then effect Total Life-Cycle Costs**
- **R&M Targets Are Not Given the Same Emphasis as Other Prime Requirements**
- **R&M Are not Always Included In Trade Studies**
- **Inadequate R&M Staffing on Programs**

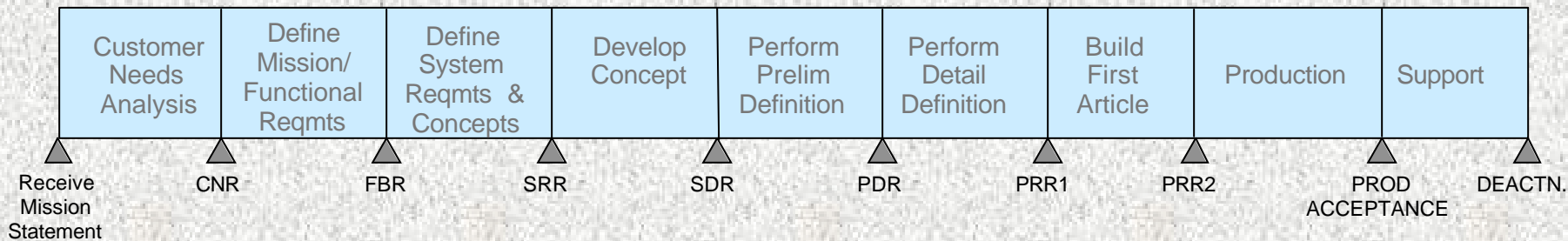
R&M Often Overlooked or Underutilized

- **The Role and Value of R&M Often Misunderstood**
- **Pressures for Cost Reduction / Affordability**
- **Acquisition Reform and Elimination of Mil-Specs**
- **R&M Requirements Often Do Not Get Same Emphasis as Other Technical Requirements**
- **Reduced R&M Customer Involvement**

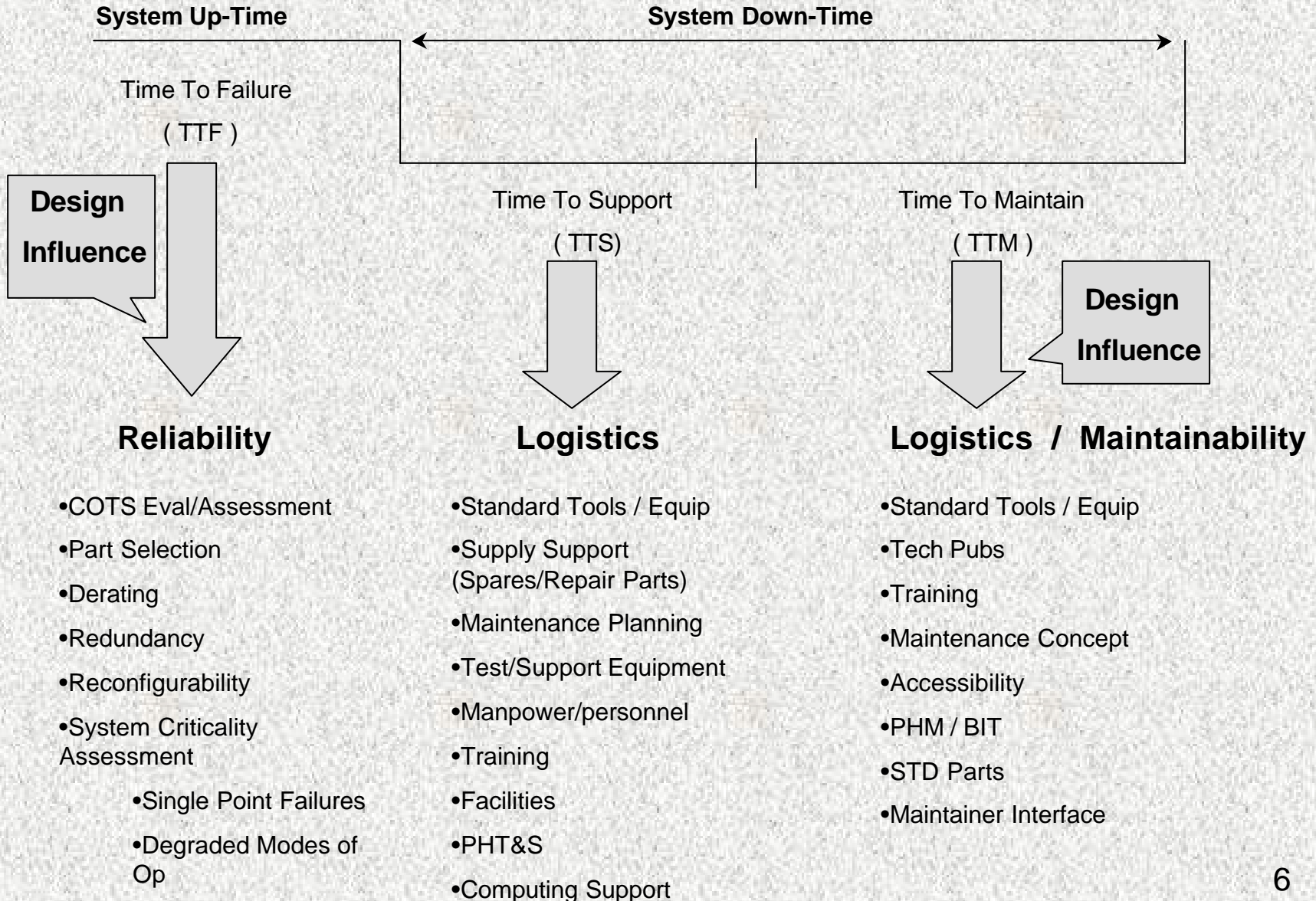
The Role Of R&M Is Often Misunderstood

- **R&M is not the Same as Logistics or Product Support**
- **R&M is More than MTBF and MTTR Predictions**
- **R&M is More than Assessment of Operational Data**
- **The Role of R&M is Up-Front Design Influence**
 - **Robust Design Which Meets Requirements**
 - **Efficient & Effective Maintenance & Support**
- **The Need for R&M Does not End after Customer Acceptance of the Product**
- **R&M is Applicable to the Entire Product Life-Cycle Phase (PLCP)**

R&M Needs to Consider all Life-Cycle Phases Up Front



- The Support Posture for Post Production Phases Needs to be Determined Early in the Process
- Future Requirements Need to be Understood - NOW



The Value of R&M is Not Fully Understood

- **The Focus of R&M Is on Design Influence Not Logistics Support**
- **Has a Major Impact on Systems Effectiveness**
 - **Mission Reliability (MR)**
 - **Operational Availability (A_o)**
 - **Mission Capable Rates (MC)**
 - **Sortie Generation Rates (SGR)**
- **Has a Major Influence on Total Ownership Cost (TOC)**
- **Facilitates Risk Management**

The Value of R&M is Not Fully Understood (Cont'd)

- **R&M Has a Major Impact in Reducing Can Not Duplicate (CND) Maintenance Actions**
- **R&M Can Help Reduce Scrap & Rework (Hidden Factory) Which Accounts for up to 25% of the Production Cost**
- **Up-Front R&M Design/Analysis/Test Can Help Reduce Costly Redesign**
- **R&M Enables Affordability**
- **R&M Increases the Warfighting Effectiveness and acts as Force Multiplier**

Affordability Focus Often Short-Sighted

- **Reduction in Development and Near-Term Costs is Primary Consideration**
 - **R&M Programs Add to Near Term (Development) Cost**
 - **However.... R&M Helps Reduce Production & O&S Costs**
- **Decisions Made Early in Development Affect Downstream Costs**
 - **Inadequate R&M Emphasis In Development Will Result in Increased Maintenance, Spares, Manpower & Support Resources**
- **Benefits of COTS Often Overstated**
- **With Respect to Overall Weapon System Cost, the Cost to Operate, Support and Maintain is the Largest Expenditure.**

Acquisition Reform Has Impacted R&M Program Acceptance

- **The Elimination Of MIL-SPECs / HDBKS / STDs Has Contributed to the Perception that R&M is “Optional”**
- **Less Control on Suppliers and Their Processes**
- **Design Analysis & Development Testing Often Challenged**
- **The R&M Customer has Less Influence on Program Issues**

Recommendations

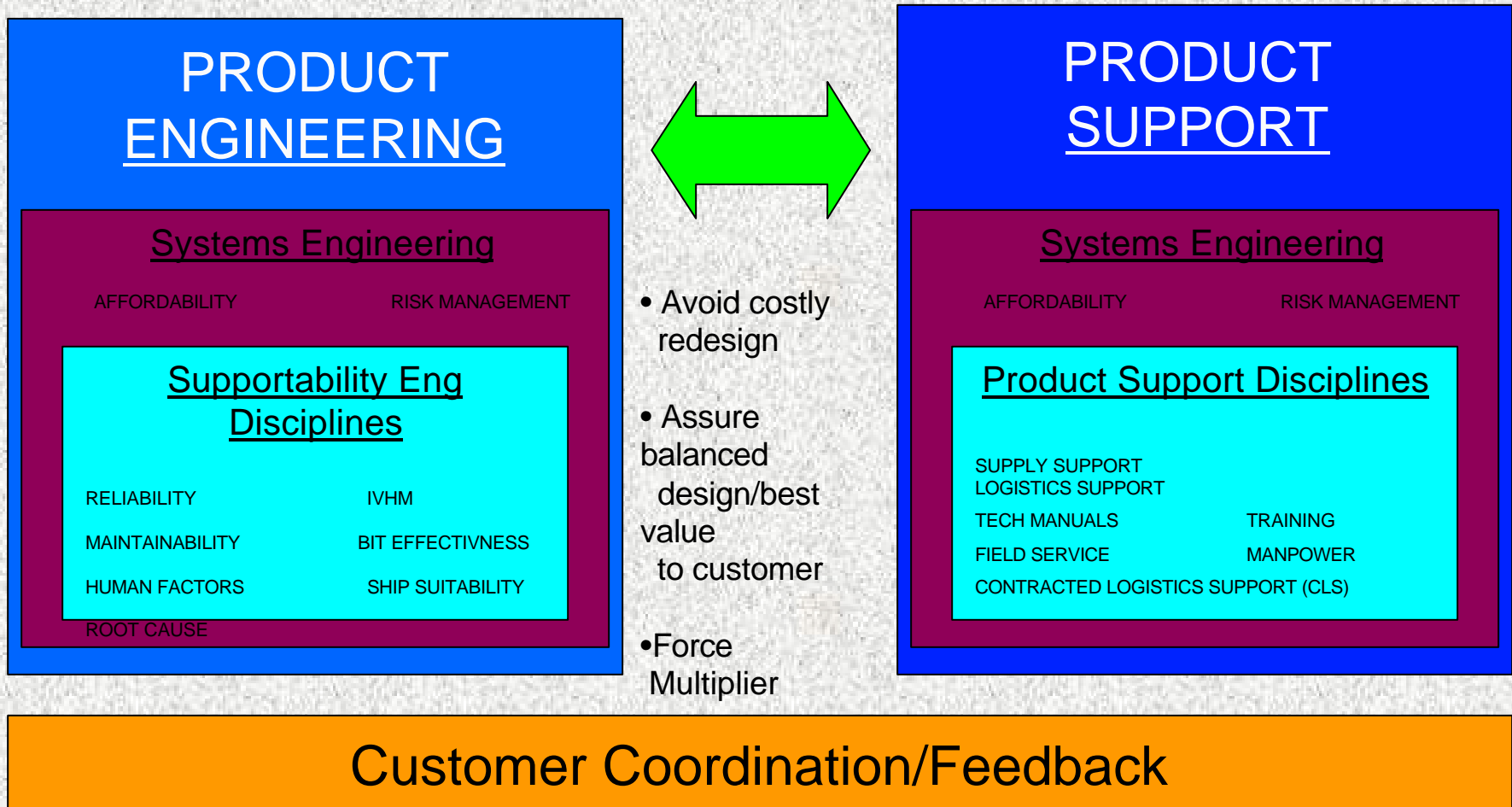
- **Treat R&M the Same as Other Essential Performance Requirements**
 - **Track Progress with TPMs**
- **Provide Awareness Briefings to Program Management & Team Leaders on the “Value Added” of R&M**
 - **Secure Enough Funding to Be Proactive Not Reactive**
 - **Perform Essential Value-Added Tasks Only**
- **Include Essential R&M Tasks in the IMP/IMS**
- **Include R&M Risks in Overall Risk Management Plan**

Recommendations (Cont'd)

- **Include Risk Mitigation Activities in IMP/IMS – can reduce risk significantly in spiral development by focusing on technology maturation & other significant R&M risks**
- **Include R&M Entrance/Exit Criteria for All Design Reviews**
- **Include R&M in all Design/Trade Studies**
- **Include R&M in Upgrades and Aftermarket Product Variants**
- **Solicit Increased Customer R&M Involvement to Ensure Customer Satisfaction & Program Buy-In**

R&M Are Essential Elements of Supportability

An integral part of a disciplined SE process that provides the bridge between front end product design thru effective field support



SUPPORTABILITY IS ADDRESSED ON SEVERAL FRONTS

ENGINEERING:

Supportability posture designed into the system. This posture will determine the support characteristics which influence the post delivery support of the weapon system

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PRODUCT SUPPORT:

The traditional disciplines that provide the support infrastructure in the using customer environment